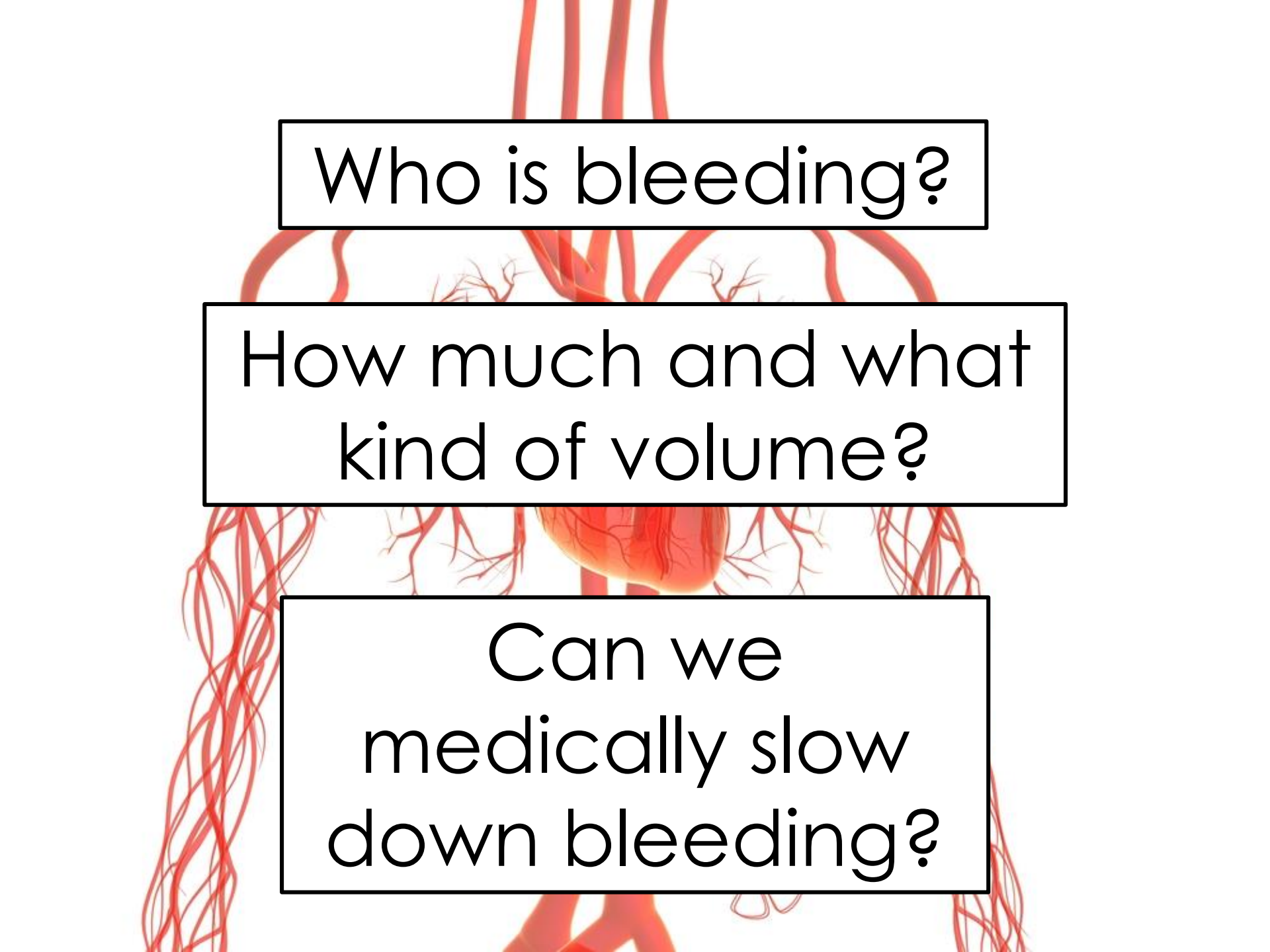
Thicker than Water

Alisa McQueen MD, FAAP, FACEP
Associate Professor of Pediatrics
The University of Chicago

THE UNIVERSITY OF CHICAGO MEDICINE
Comer Children's
AT THE FOREFRONT OF KIDS' MEDICINE

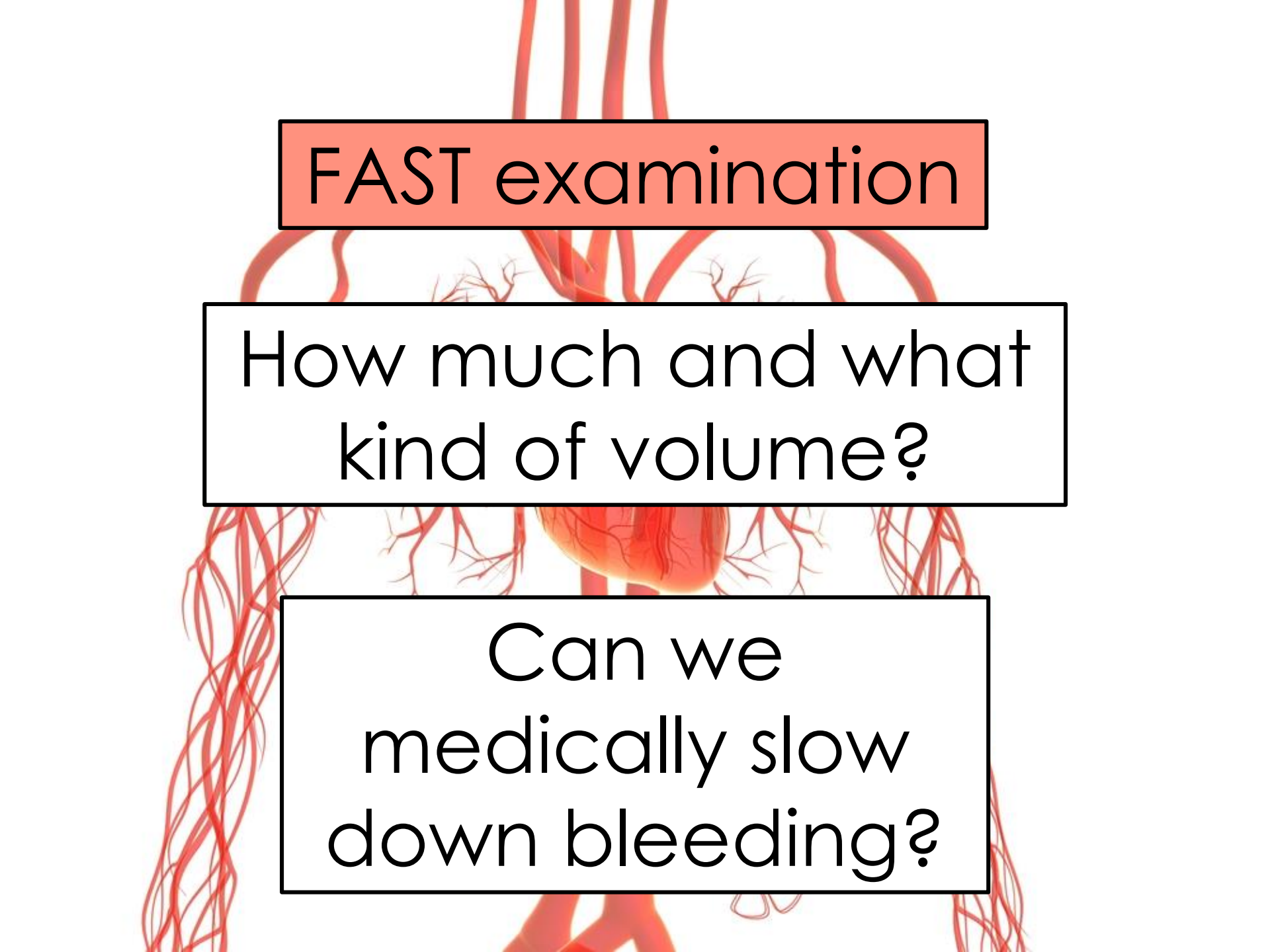
I have no relevant financial relationships to disclose.



Who is bleeding?

How much and what kind of volume?

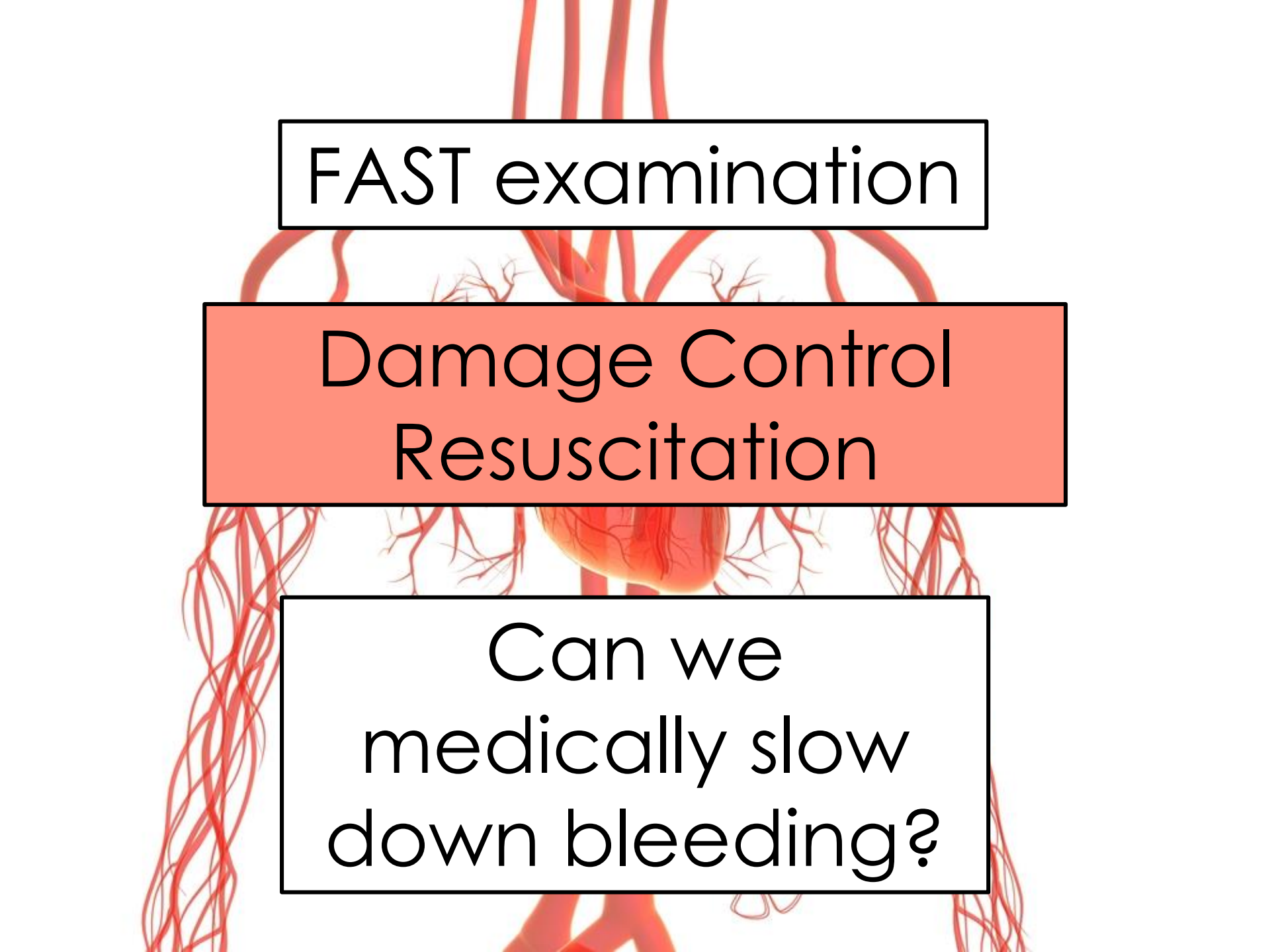
Can we medically slow down bleeding?



FAST examination

How much and what kind of volume?

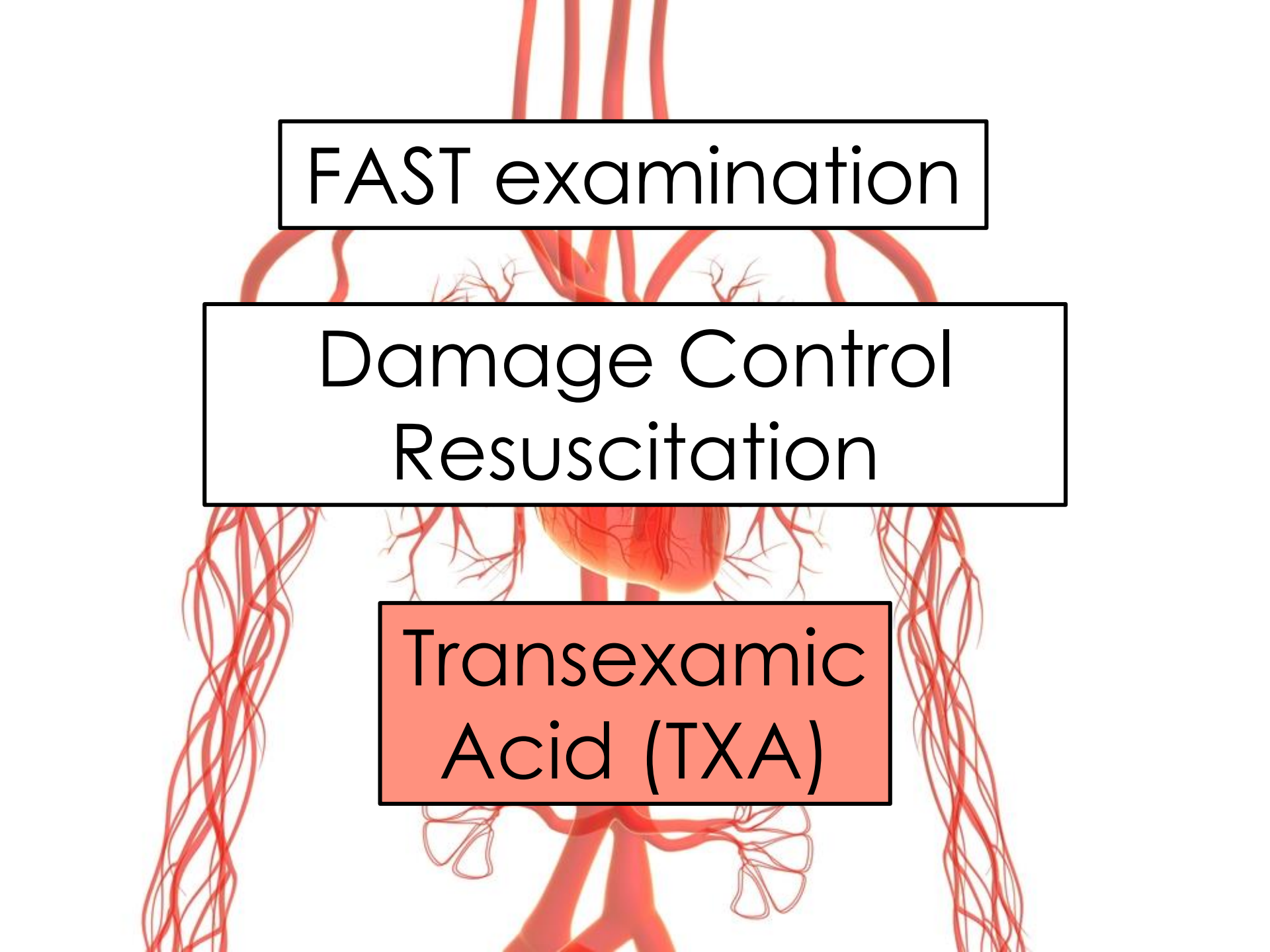
Can we medically slow down bleeding?

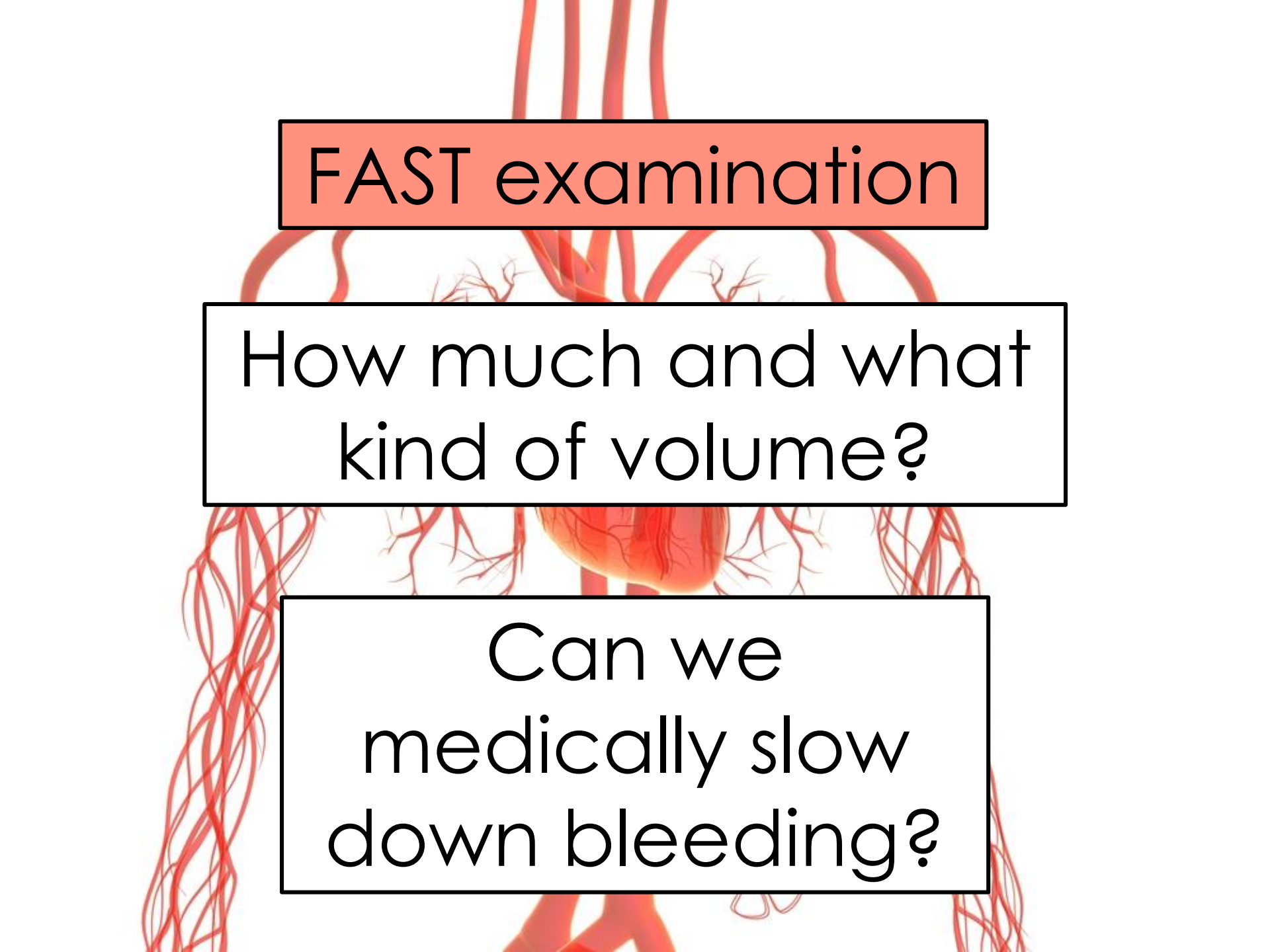


FAST examination

Damage Control Resuscitation

Can we medically slow down bleeding?


FAST examination
Damage Control Resuscitation
Transexamic Acid (TXA)



FAST examination

How much and what kind of volume?

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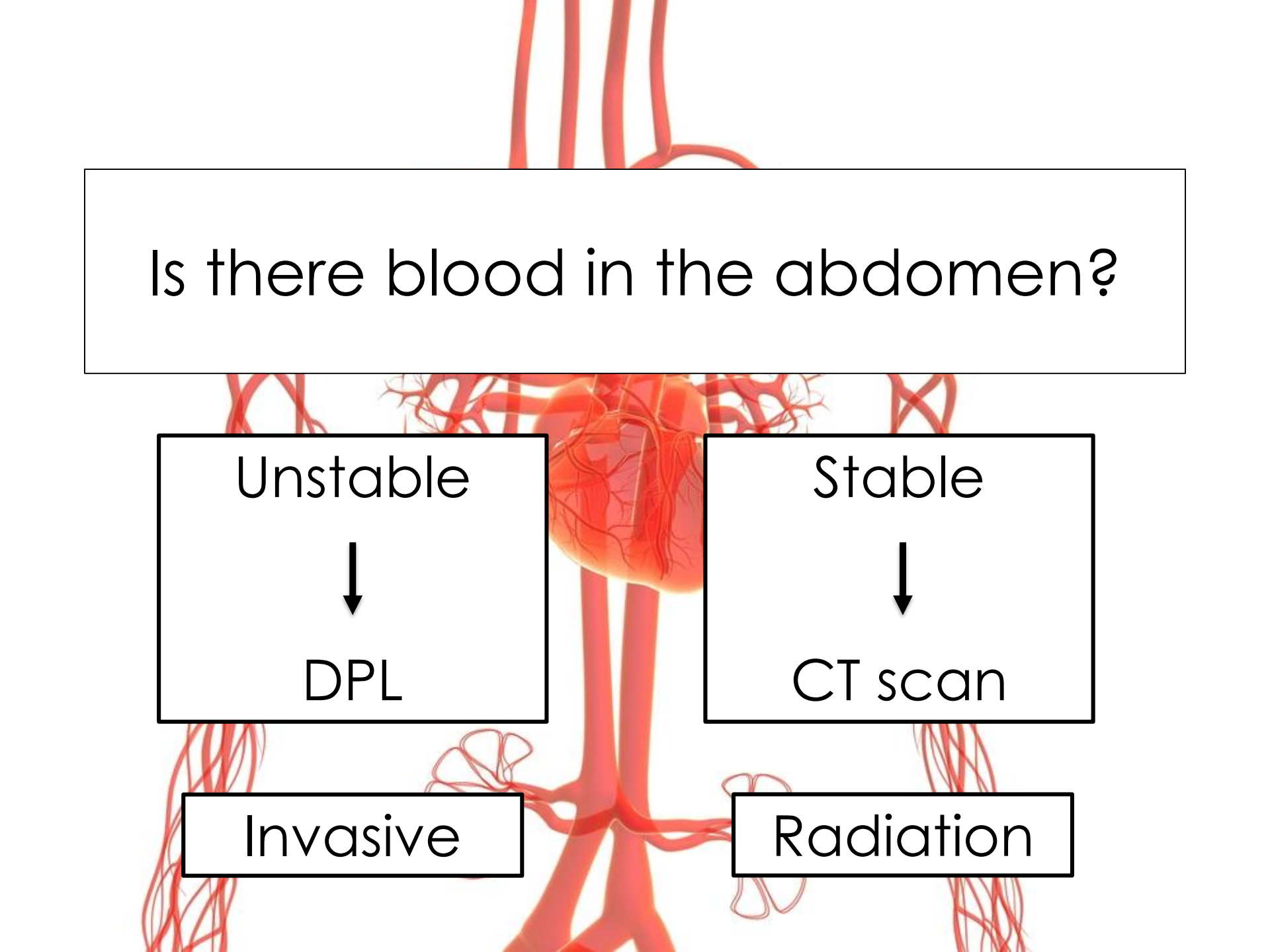
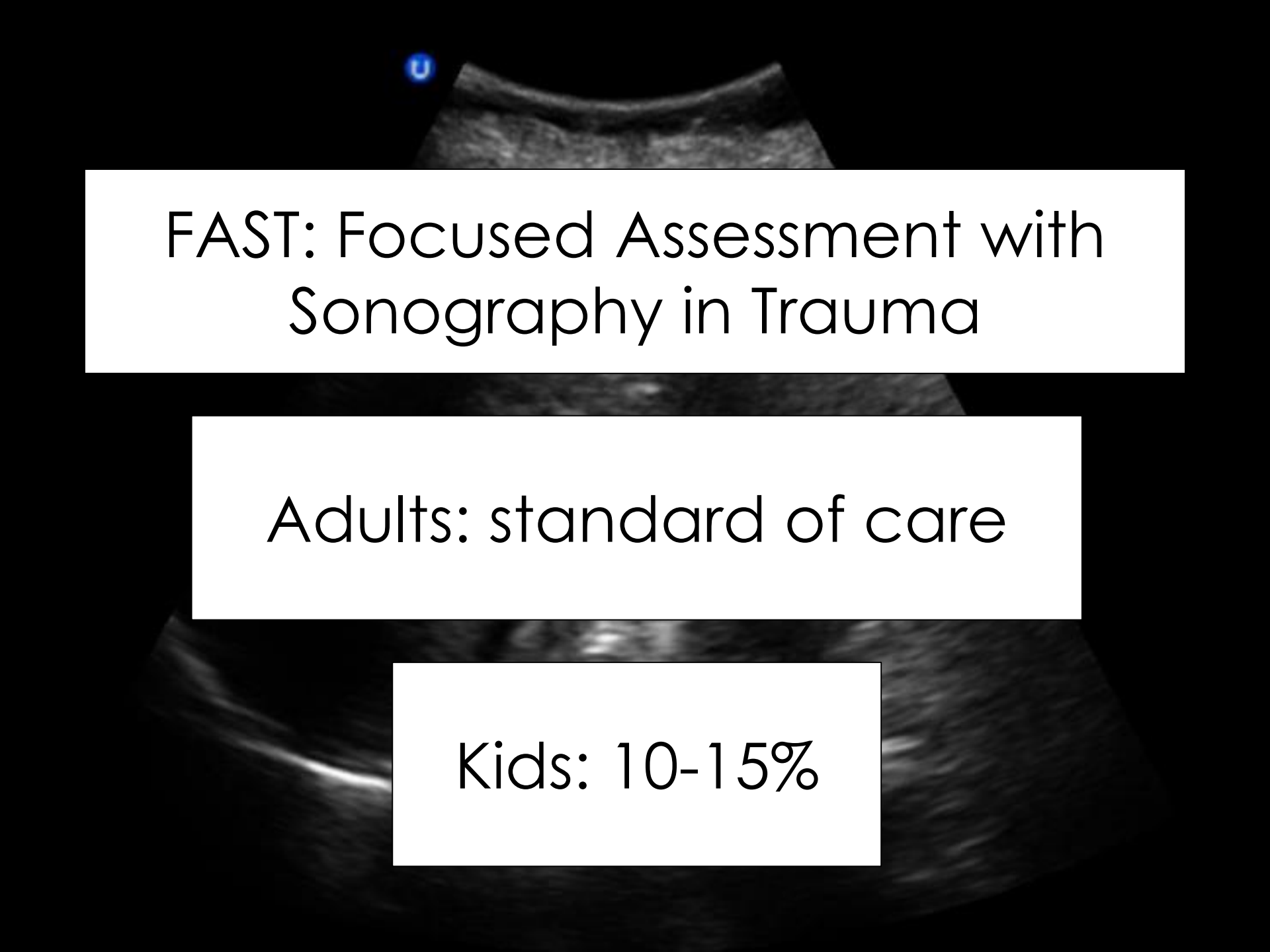

Is there blood in the abdomen?
Unstable
DPL
Stable
CT scan
Invasive
Radiation

FAST: Focused Assessment with Sonography in Trauma

Adults: standard of care

Kids?



FAST: Focused Assessment with Sonography in Trauma

Adults: standard of care

Kids: 10-15%


Why don’t we do more pediatric FAST exams?

FAST in Pediatric Trauma

All children < 16 with blunt abdominal trauma

FAST/CT/procedures at the discretion of treatment team

FAST compared with no FAST

Calder B et al. Focused Assessment with Sonography for Trauma in children with blunt abdominal trauma: a multi-institutional analysis. J Trauma Acute Care Surg 2017;83:218-224.

FAST in Pediatric Trauma

2188 patients

37.9% FAST
(more likely with MVC, less likely with falls or assault)

Calder B et al. Focused Assessment with Sonography for Trauma in children with blunt abdominal trauma: a multi-institutional analysis. J Trauma Acute Care Surg 2017;83:218-224.

FAST in Pediatric Trauma

69 % had negative FAST

Grade 3+ liver/spleen injury

Intra-abdominal injury requiring intervention

56 % had negative FAST

Calder B et al. Focused Assessment with Sonography for Trauma in children with blunt abdominal trauma: a multi-institutional analysis. J Trauma Acute Care Surg 2017;83:218-224.

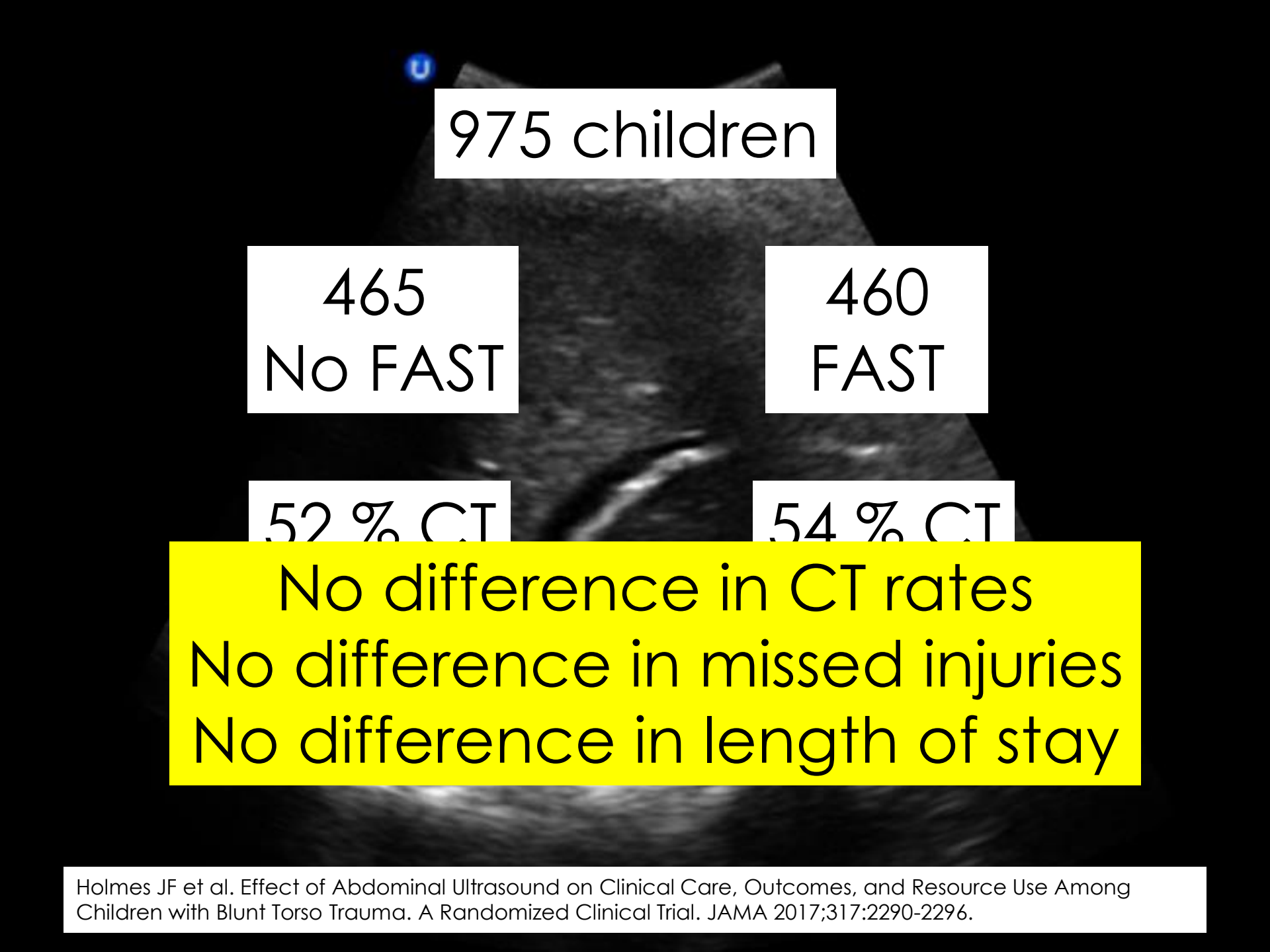
FAST in Pediatric Trauma Trial

Stable children with blunt torso trauma randomized standard treatment vs FAST

Suspicion for intra abdominal injury before/after FAST

CT at treating team discretion

Holmes JF et al. Effect of Abdominal Ultrasound on Clinical Care, Outcomes, and Resource Use Among Children with Blunt Torso Trauma. A Randomized Clinical Trial. JAMA 2017;317:2290-2296.

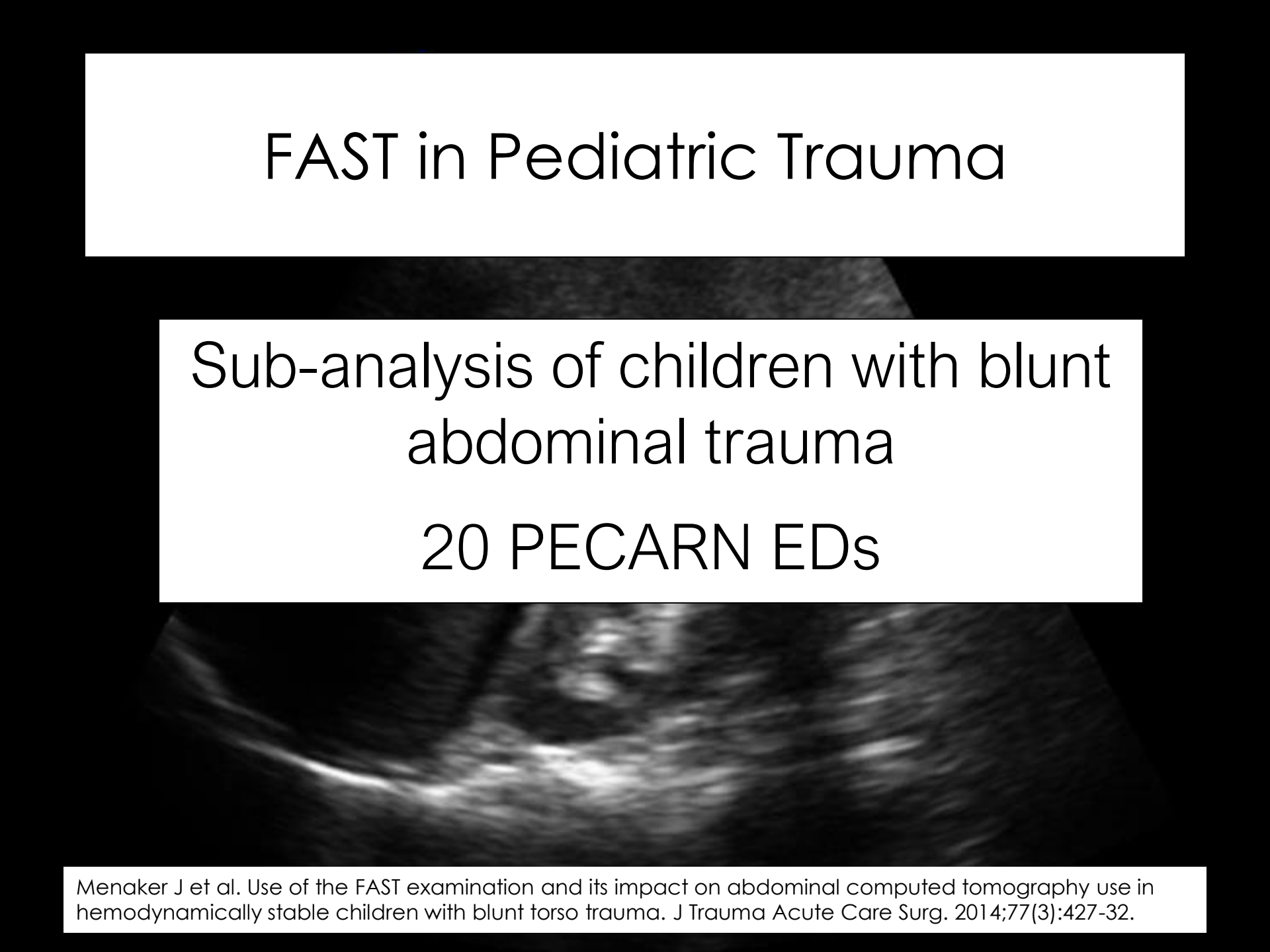


Holmes JF et al. Effect of Abdominal Ultrasound on Clinical Care, Outcomes, and Resource Use Among Children with Blunt Torso Trauma. A Randomized Clinical Trial. JAMA 2017;317:2290-2296.

FAST in Pediatric Trauma

Sub-analysis of children with blunt abdominal trauma

20 PECARN EDs



Menaker J et al. Use of the FAST examination and its impact on abdominal computed tomography use in hemodynamically stable children with blunt torso trauma. J Trauma Acute Care Surg. 2014;77(3):427-32.

FAST in Pediatric Trauma

How suspicious are you for intra-abdominal injury?

- Frequency of FAST
- Frequency of CT
- Missed intra abdominal injury

Menaker J et al. Use of the FAST examination and its impact on abdominal computed tomography use in hemodynamically stable children with blunt torso trauma. J Trauma Acute Care Surg. 2014;77(3):427-32.

Very low (<1%)	Low (1-5%)	Moderate (6-10%)	High (11-50%)	Very high (>50%)
11 %	13 %	20 %	23 %	30 %
1.01	0.84	0.86	0.98	0.98

Rate of FAST increased as the suspicion for intra - abdominal injury increased

Menaker J et al. Use of the FAST examination and its impact on abdominal computed tomography use in hemodynamically stable children with blunt torso trauma. J Trauma Acute Care Surg. 2014;77(3):427-32.

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RR of CT decreased significantly for low-moderate suspicion injuries when FAST performed

Menaker J et al. Use of the FAST examination and its impact on abdominal computed tomography use in hemodynamically stable children with blunt torso trauma. J Trauma Acute Care Surg. 2014;77(3):427-32.

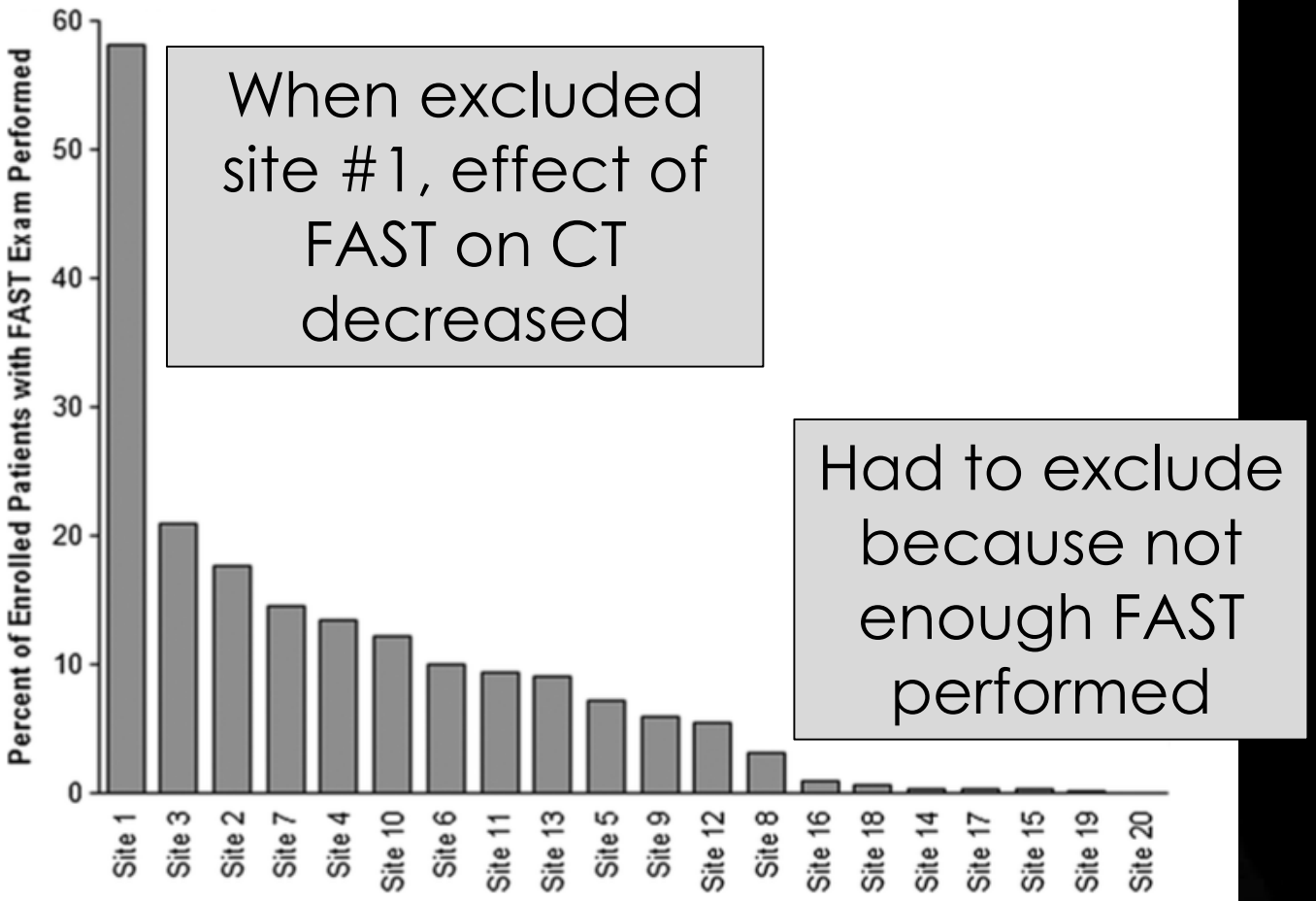
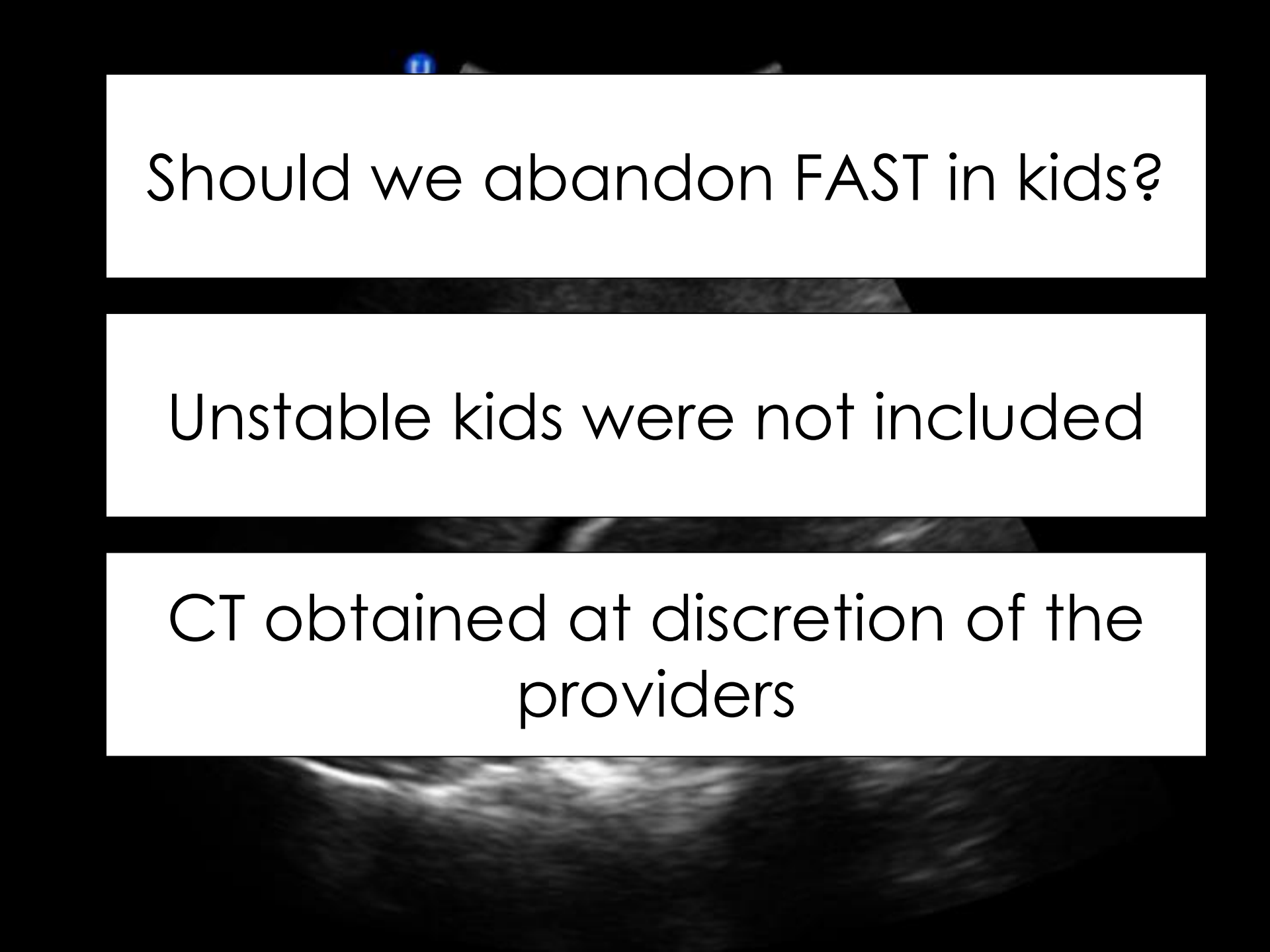


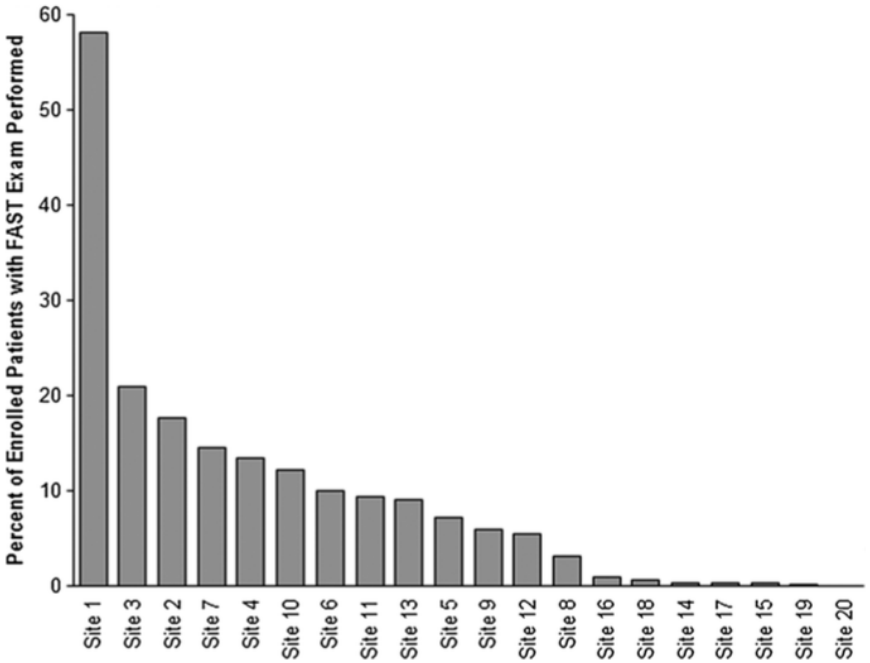
Figure 1. Percentage of patients with FAST examinations.

Menaker J et al. Use of the FAST examination and its impact on abdominal computed tomography use in hemodynamically stable children with blunt torso trauma. J Trauma Acute Care Surg. 2014;77(3):427-32.

Should we abandon FAST in kids?


Should we abandon FAST in kids?
Unstable kids were not included
CT obtained at discretion of the providers

Maybe we need to do it more



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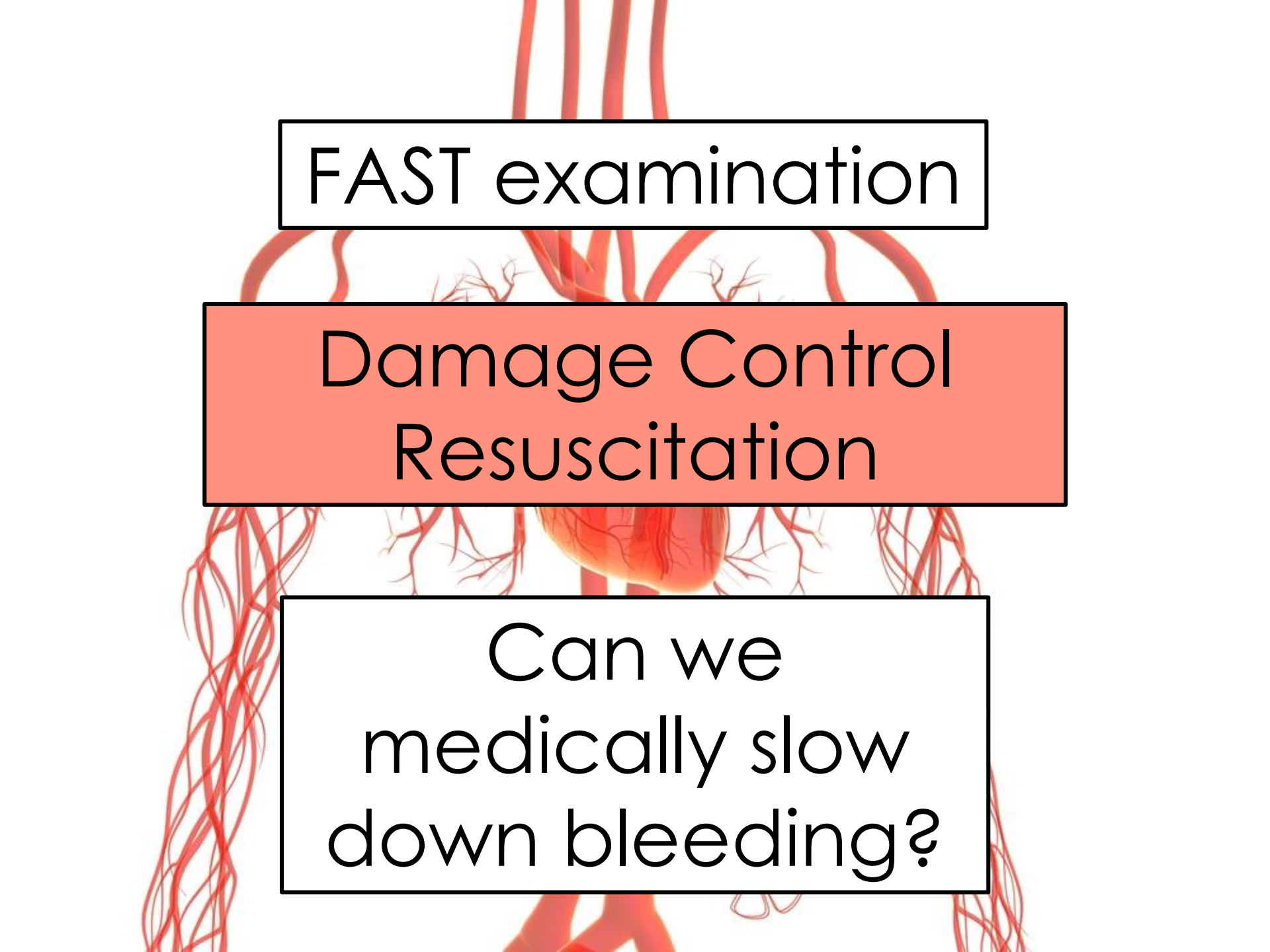
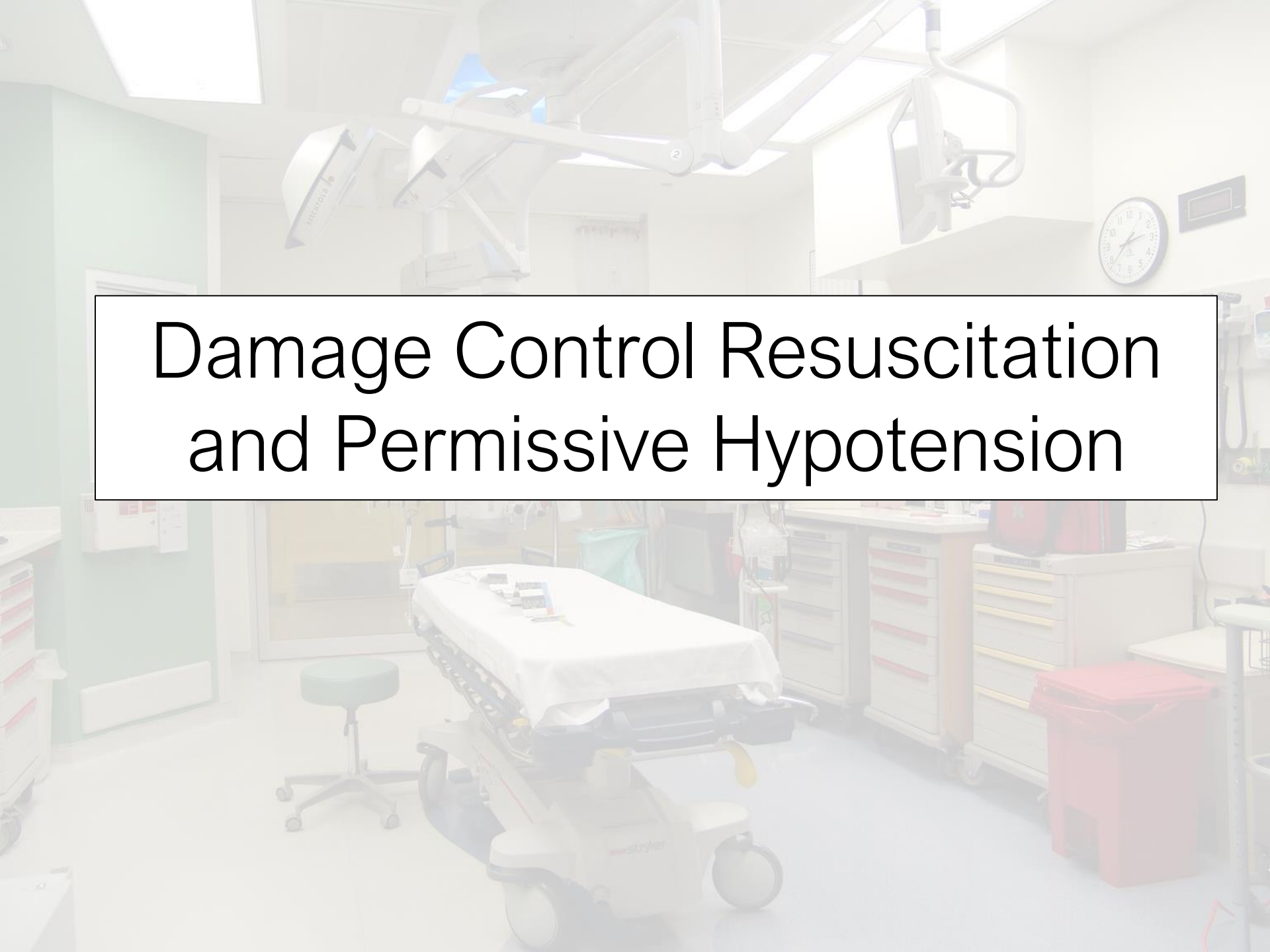


FAST examination

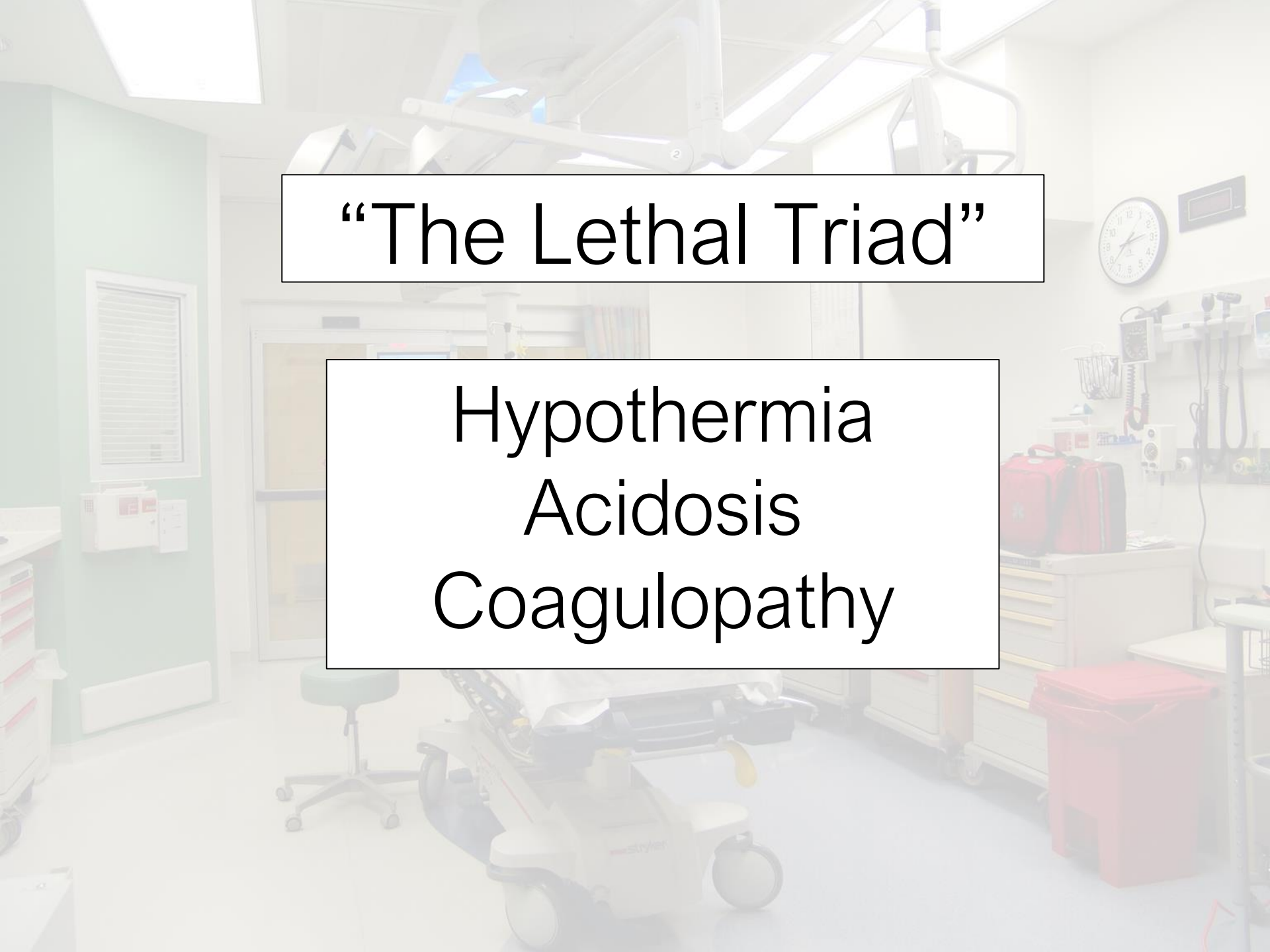
Damage Control Resuscitation

Can we medically slow down bleeding?


BIRCHIOLD
stryker



Damage Control Resuscitation and Permissive Hypotension


“The Lethal Triad”
Hypothermia
Acidosis
Coagulopathy

Damage Control Resuscitation

Permissive Hypotension
Early blood products over saline

Retrospective study of adults with penetrating trauma and hypotension managed with damage control surgery and damage control resuscitation

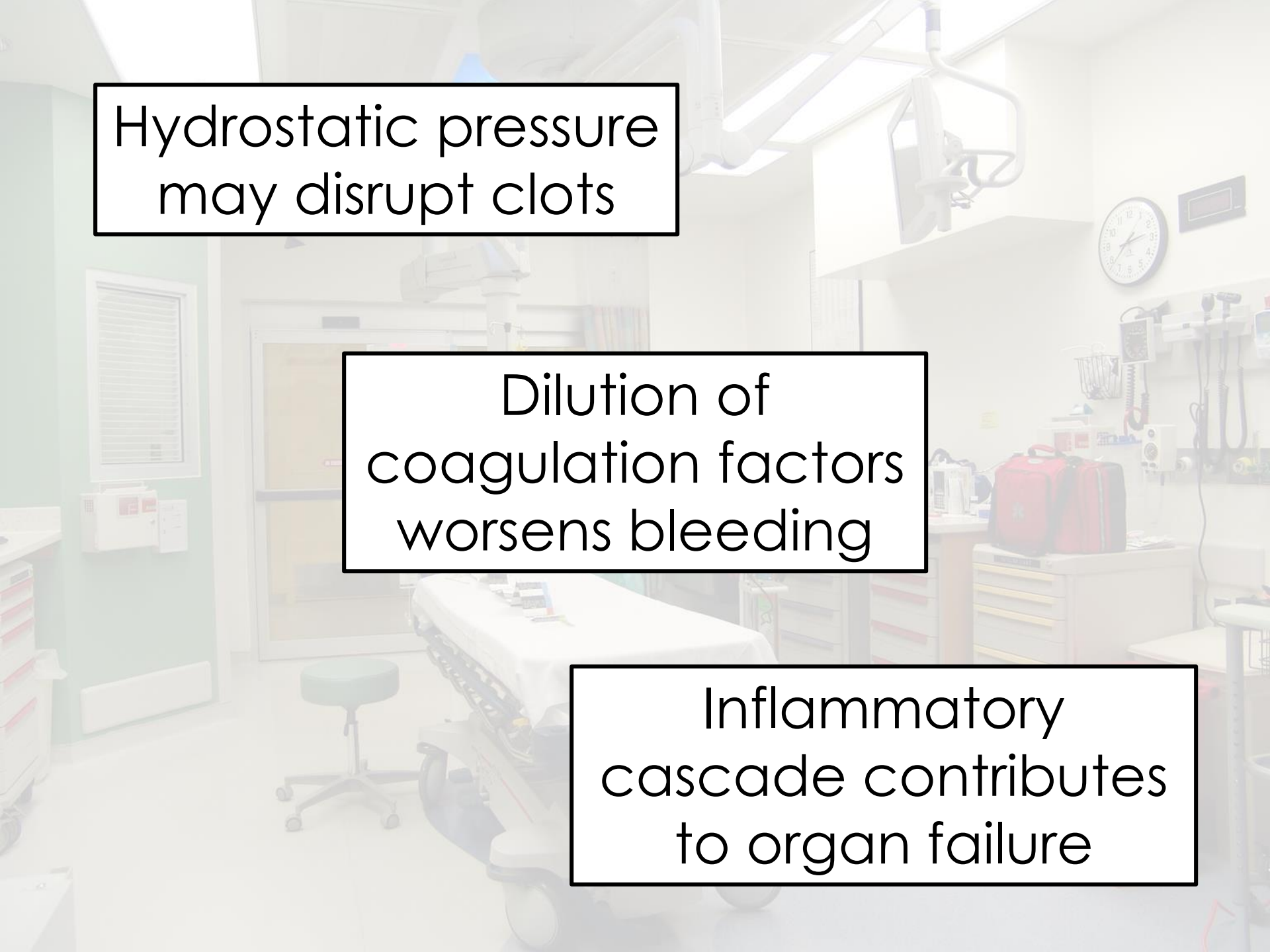
Standard fluid (150+ crystalloid)

Restricted fluid (<150 ml crystalloid)

Duke MD et al. Restrictive fluid resuscitation in combination with damage control resuscitation: time for adaptation. J Trauma Acute Care Surg 2012;73:674-678.

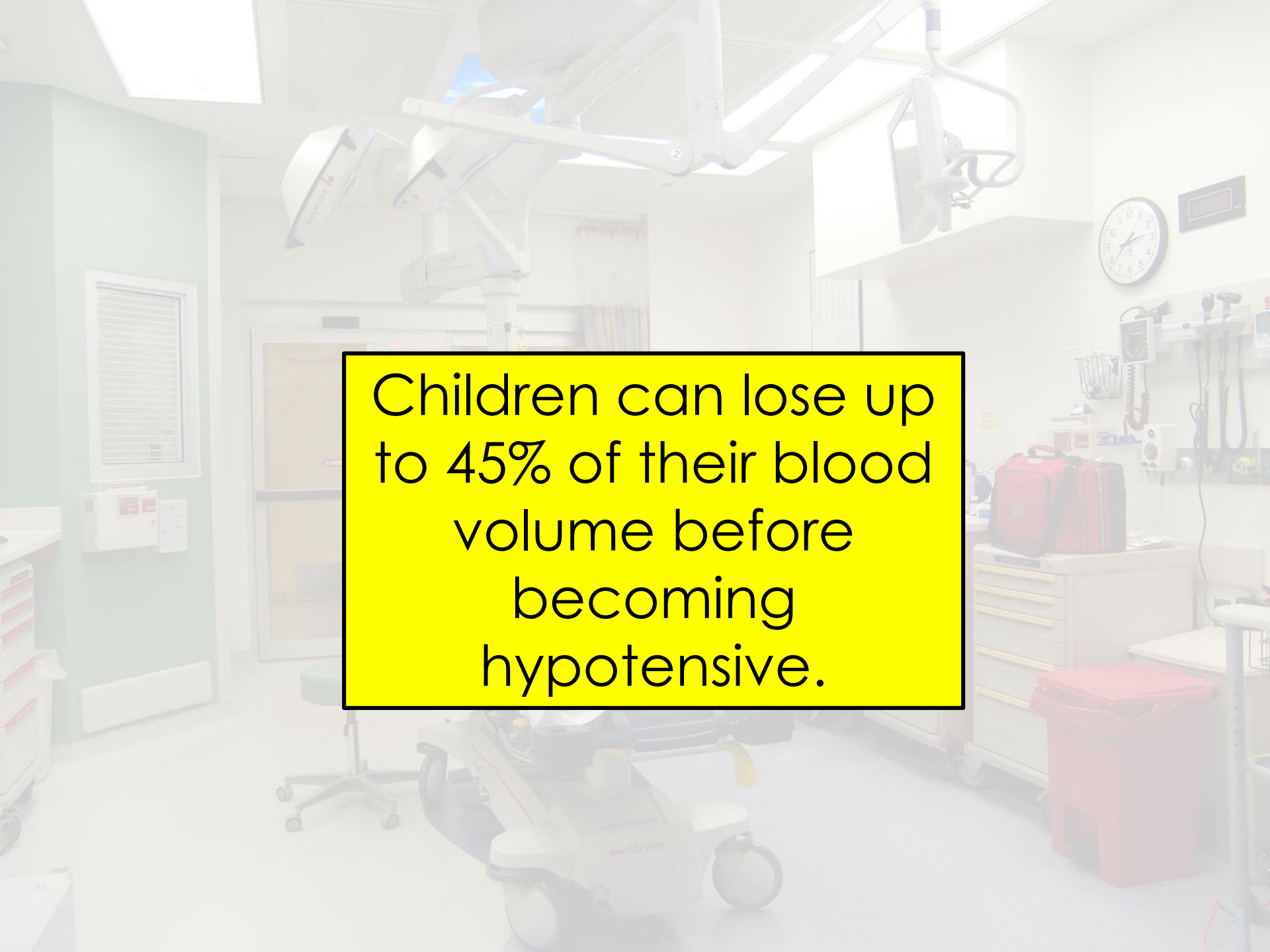
Standard fluid (avg 2757ml)	Restricted fluid (avg 129ml)
Mortality in OR: 32%	Mortality in OR: 9%
Mortality in ICU: 5%	Mortality in ICU: 12%
Overall mortality: 37%	Overall mortality: 21%

Duke MD et al. Restrictive fluid resuscitation in combination with damage control resuscitation: time for adaptation. J Trauma Acute Care Surg 2012;73:674-678.

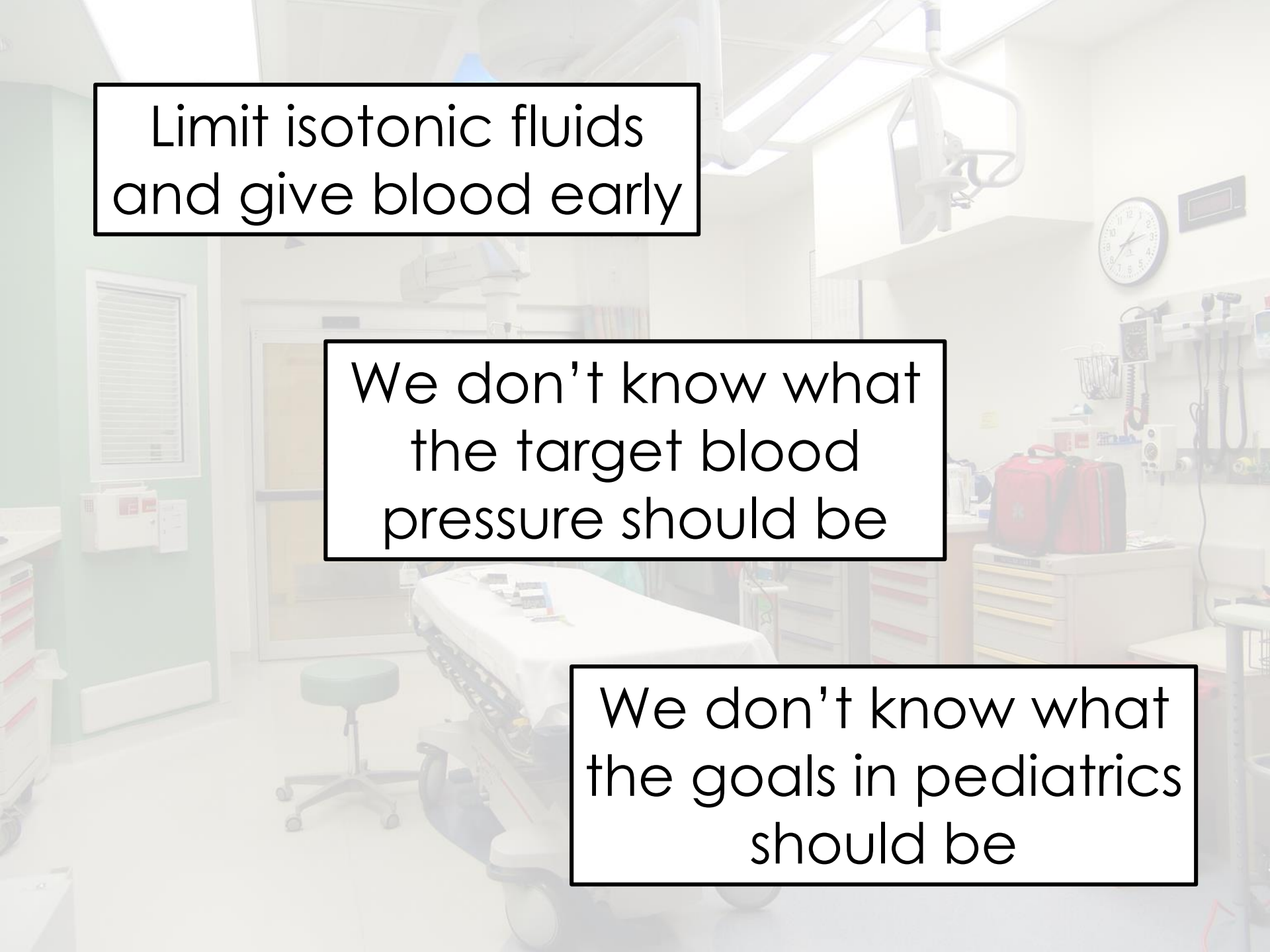

Hydrostatic pressure may disrupt clots
Dilution of coagulation factors worsens bleeding
Inflammatory cascade contributes to organ failure

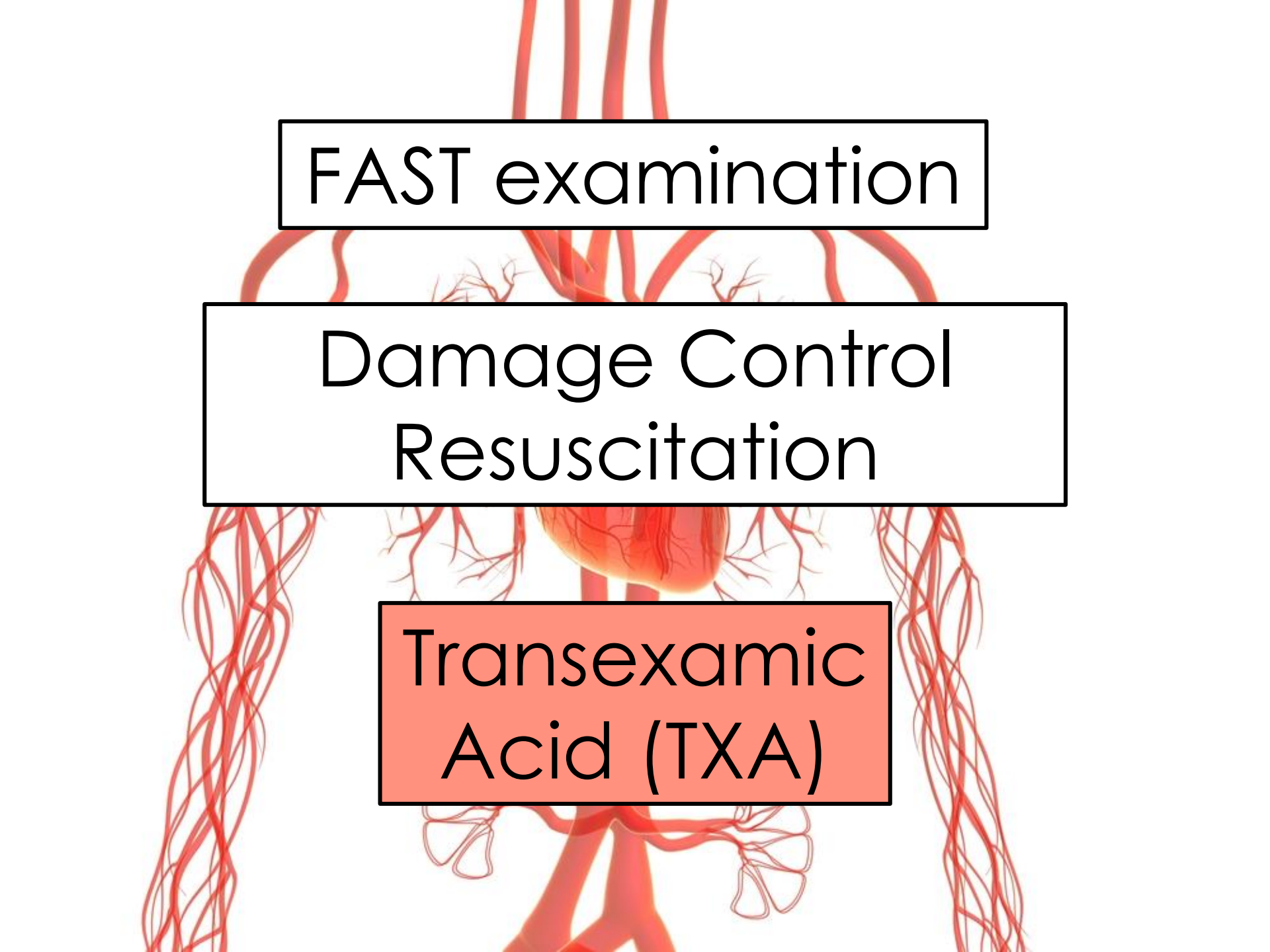
Blood volume varies by age.

Infants: 90 – 100 cc/kg
Young children: 70 – 80 cc/kg
Adolescents: 60– 65 cc/kg


Children can lose up to 45% of their blood volume before becoming hypotensive.


Children with
traumatic brain injury
may be hypotensive.


Limit isotonic fluids and give blood early
We don't know what the target blood pressure should be
We don't know what the goals in pediatrics should be


FAST examination
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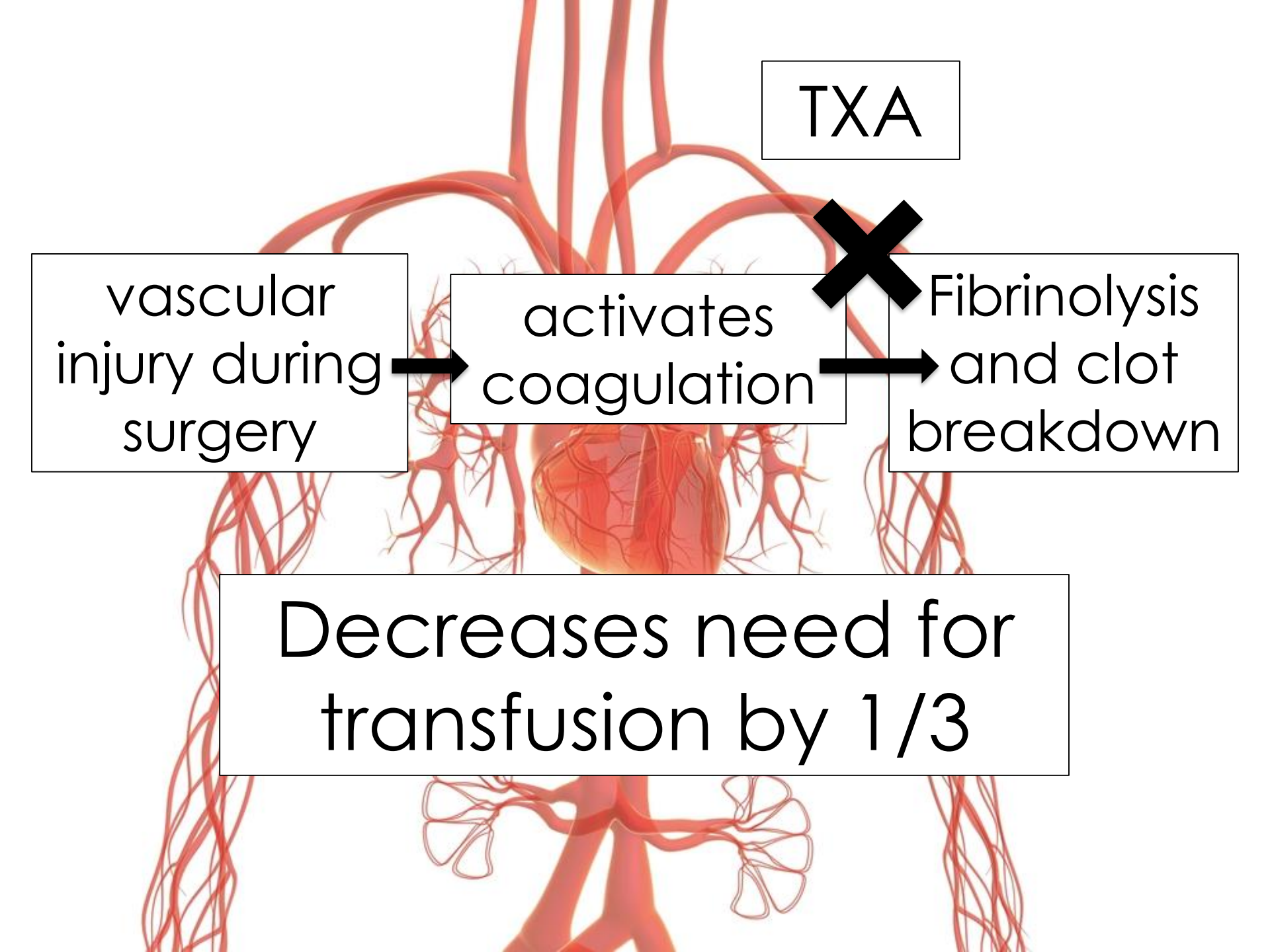
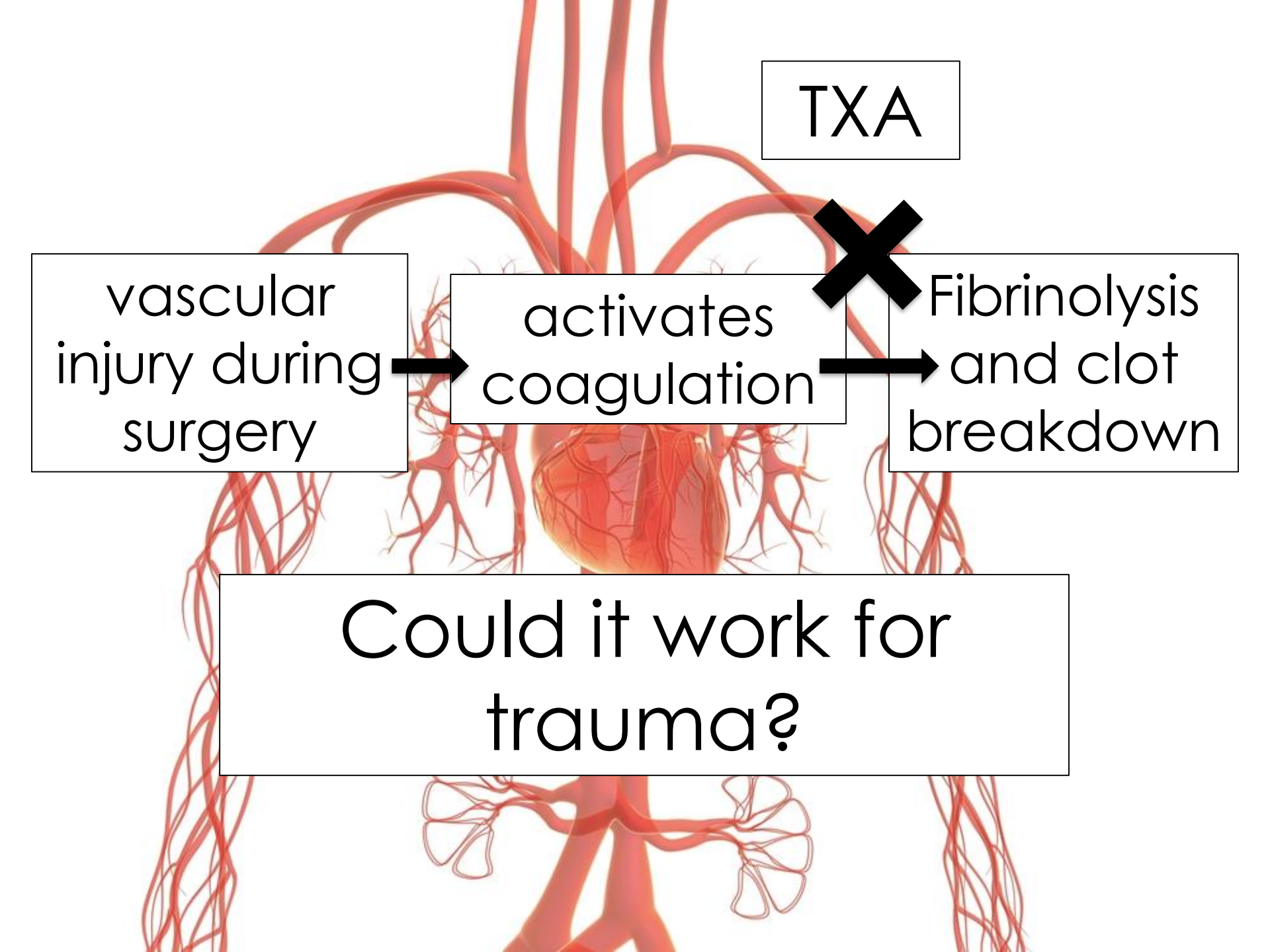
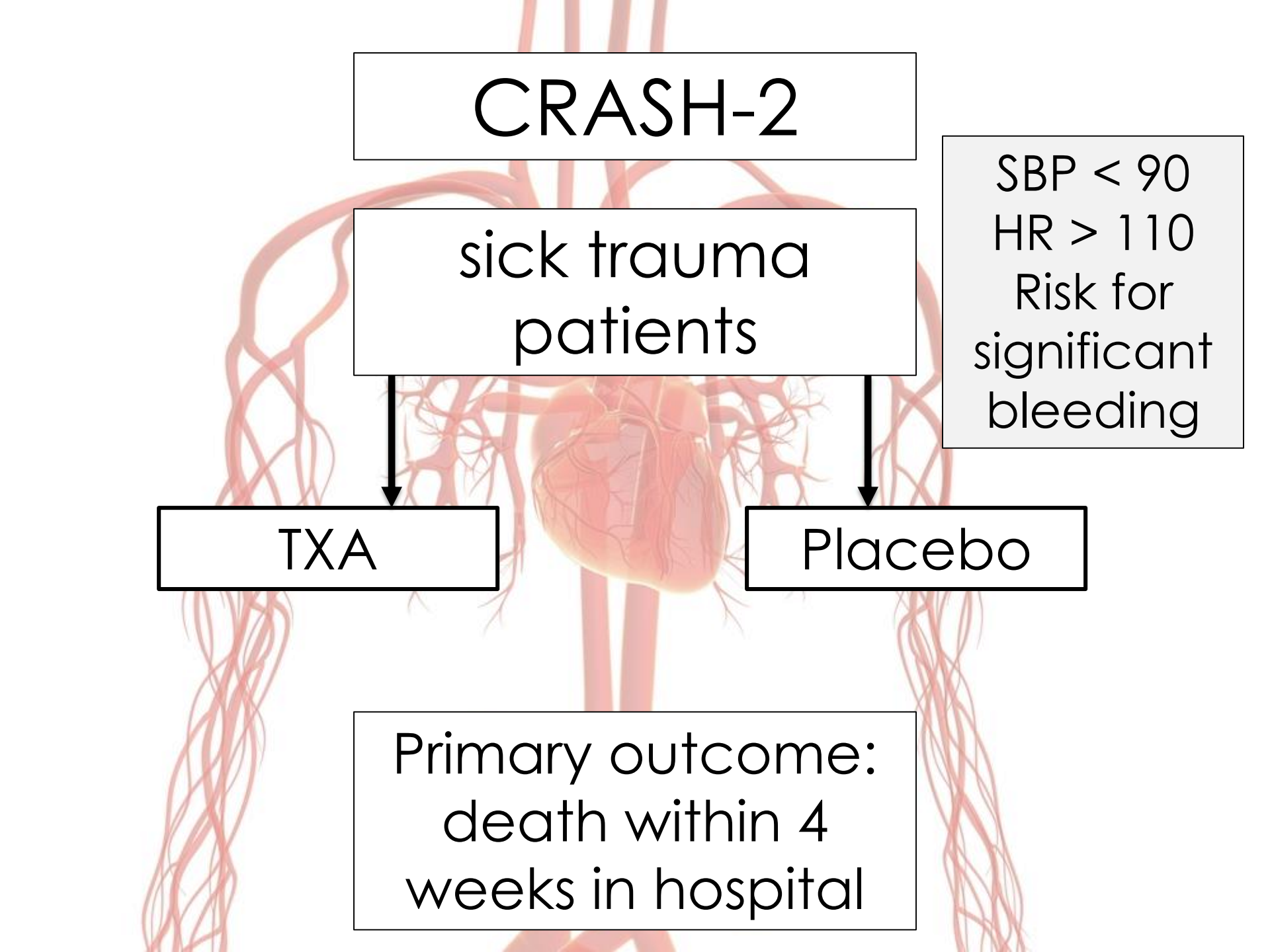

TXA
vascular injury during surgery
activates coagulation
Fibrinolysis and clot breakdown
Decreases need for transfusion by 1/3


TXA
vascular injury during surgery
activates coagulation
Fibrinolysis and clot breakdown
Could it work for trauma?

Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial

*CRASH-2 trial collaborators**

Effects of TXA on death, vascular occulsive events, and blood transfusion in trauma patients with significant hemorrhage (CRASH-2): a randomised, placebo-controlled trial. Lancet 2010;376:23-32.


CRASH-2
sick trauma patients
SBP < 90
HR > 110
Risk for significant bleeding
TXA
Placebo
Primary outcome: death within 4 weeks in hospital

CRASH-2

274 hospitals
40 countries

20,211 trauma patients

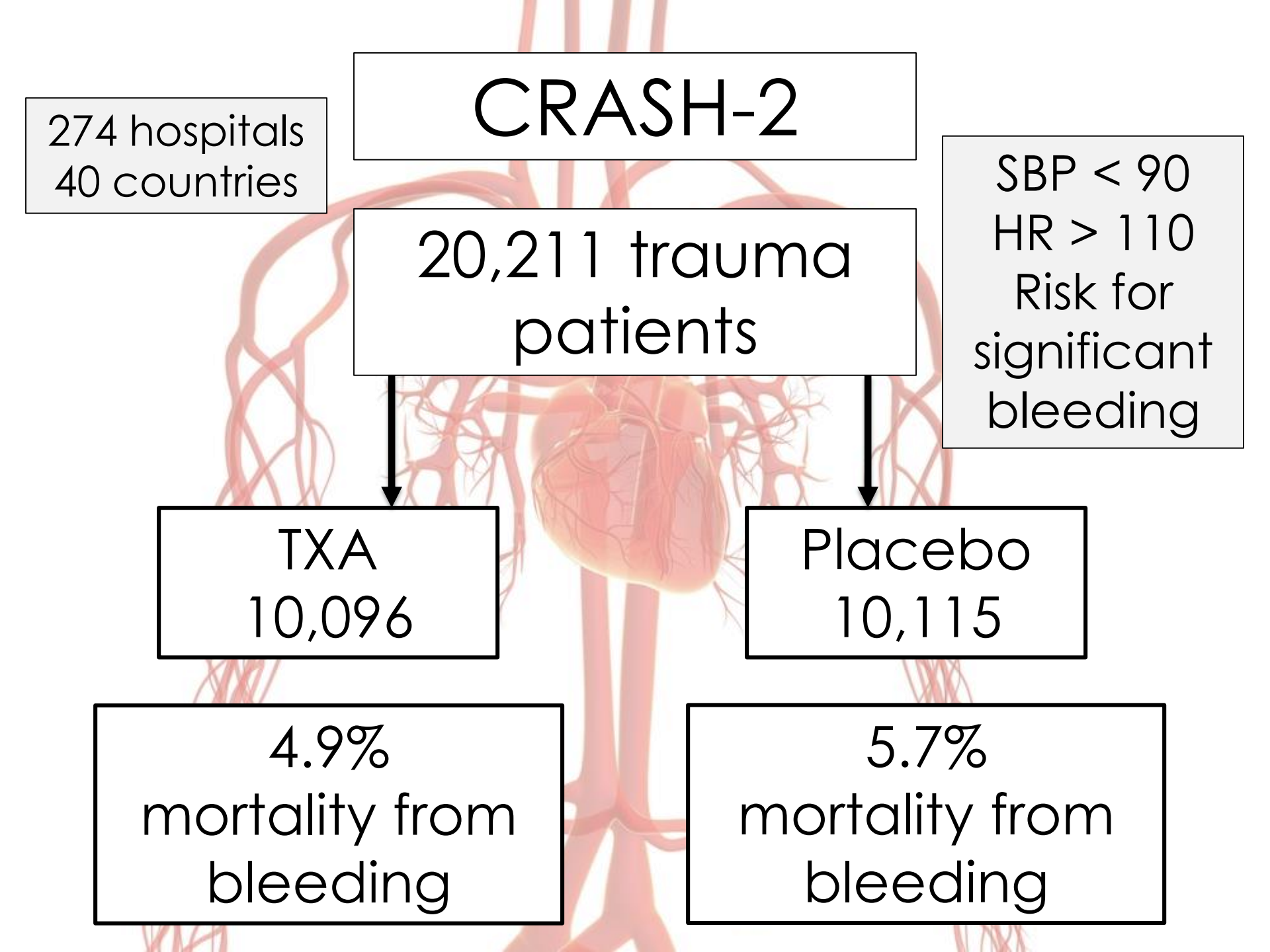
SBP < 90
HR > 110
Risk for significant bleeding

TXA
10,096

Placebo
10,115

14.5% mortality from all causes

16% mortality from all causes


CRASH-2
274 hospitals
40 countries
20,211 trauma patients
SBP < 90
HR > 110
Risk for significant bleeding
TXA
10,096
Placebo
10,115
4.9%
mortality from bleeding
5.7%
mortality from bleeding

CRASH-2 sub-analysis

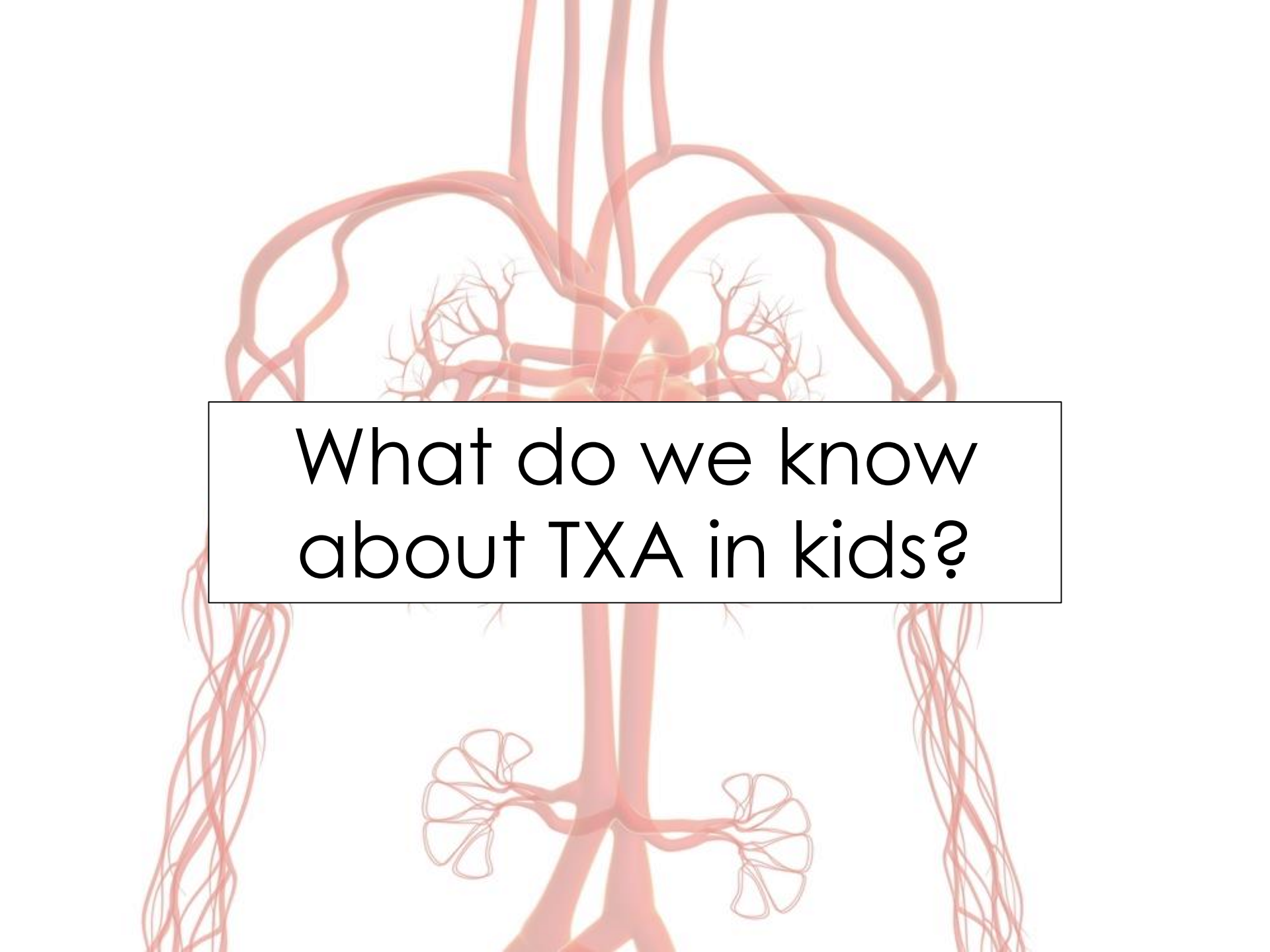
1. Time from injury (<1, 1-3, >3h)
2. Severity (SBP <75, 76-89, >89)
3. GCS (3-8, 9-12, 13-15)
4. Type of injury (penetrating/ blunt)

CRASH-2 sub-analysis

1.
2.
4. Ty

The sooner TXA given, the stronger the benefit.

If given after 3 hours, increased risk of thrombotic events.



What do we know about TXA in kids?

What do we know about TXA in kids?

Coagulation cascade is the same by about age 1 year

Safe use in elective surgery (cardiac, scoliosis, craniofacial)

TXA use in U.S. Children's Hospitals

36 hospitals 2009-2013
TXA use in children < 18 years

64% cardiothoracic surgery
18% scoliosis
3.6% craniofacial
14% other
0.3% trauma

Nishijima D et al. Tranexamic acid use in US childrens hospitals. J Emerg Med 2016;50:868-74.

Pediatric TXA in combat setting

Retrospective review of TXA use in children < 18 with trauma in Afghanistan

766 children
Mean age 11
88% male
73% penetrating injury

Eckert MJ et al. TXA administration to pediatric trauma patients in a combat setting (PED-TRAX).J Trauma Acute Care Surg 2014;77:852-858.

Pediatric TXA in combat setting

Retrospective review of TXA use in children < 18 with trauma in Afghanistan

9% received TXA
Tended to be sicker
When controlled for severity, decreased mortality (OR 0.3, p=0.03)

Eckert MJ et al. TXA administration to pediatric trauma patients in a combat setting (PED-TRAX).J Trauma Acute Care Surg 2014;77:852-858.

RCPCH

Royal College of
Paediatrics and Child Health

Leading the way in Children's Health

Evidence Statement

Major trauma and the use of tranexamic acid in children

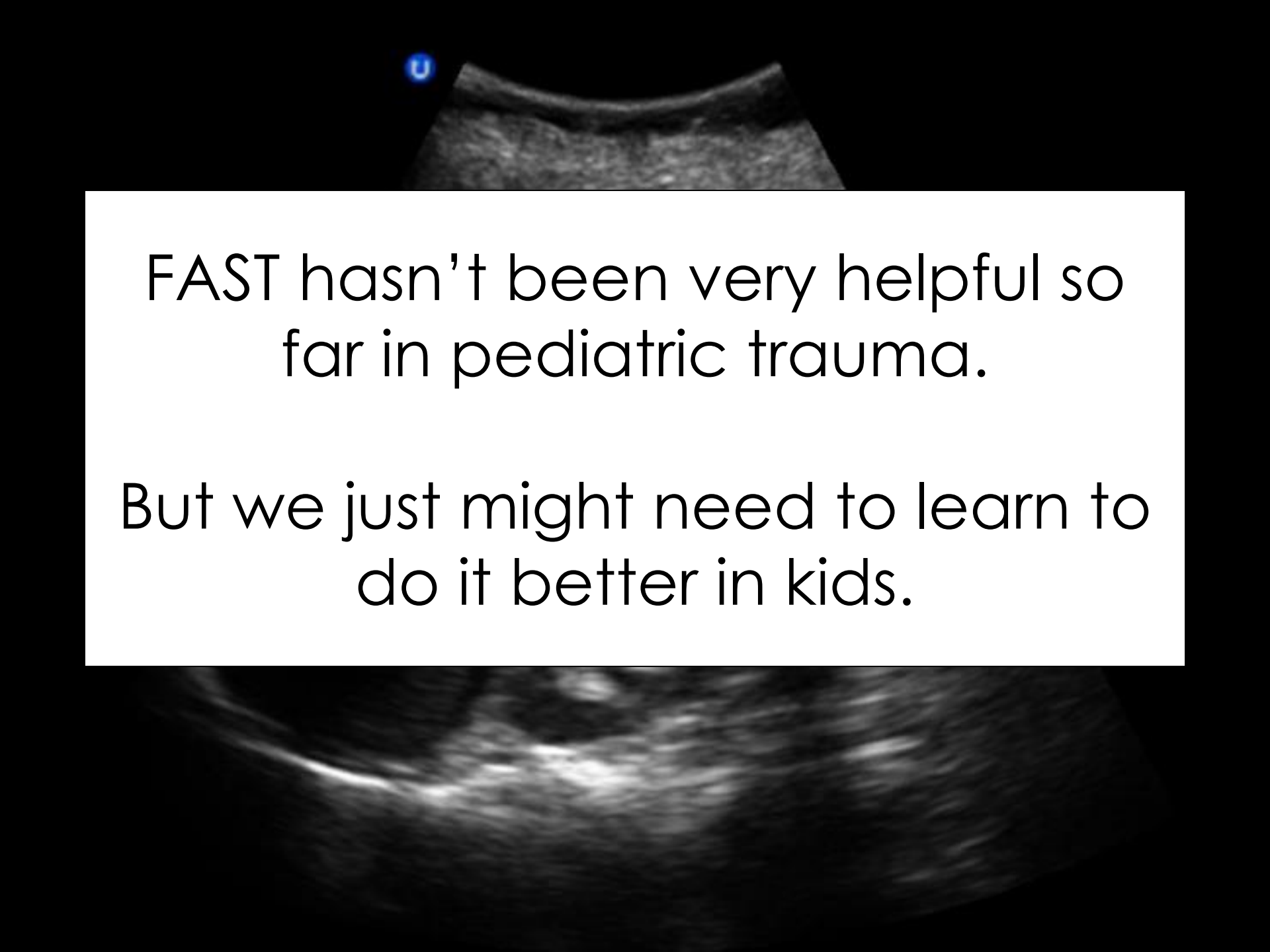
November 2012

Key points

- Tranexamic acid reduces mortality in adult trauma
- Early administration is vital for efficacy
- Due to the lack of published data on the use of tranexamic acid in paediatric patients who have undergone major trauma there is no evidence for a specific dose in this situation
- The RCPCH and NPPG Medicines Committee recommend a pragmatic dosage schedule – 15mg/kg tranexamic acid loading dose (max 1g) over 10 minutes followed by 2mg/kg per hour

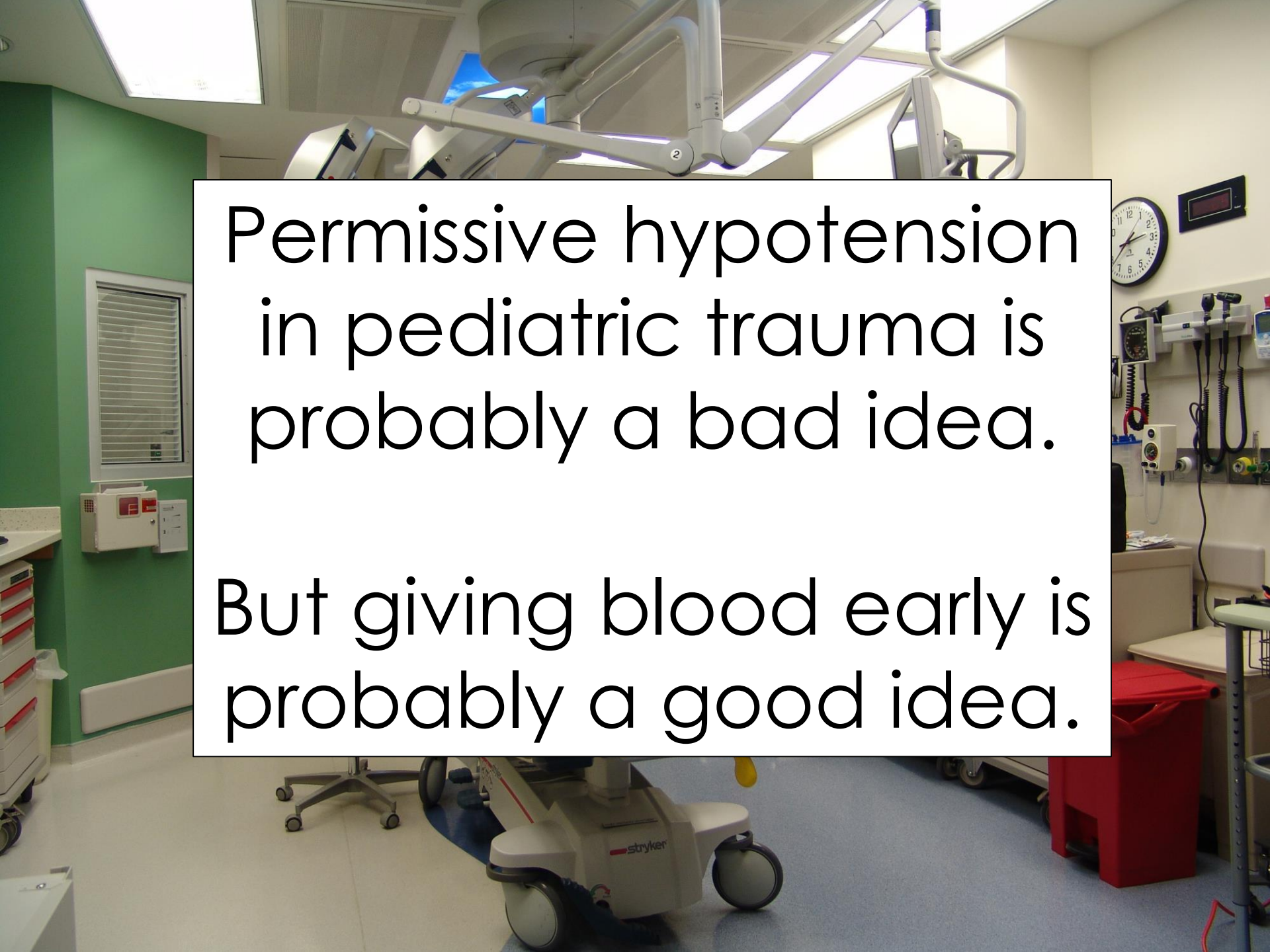
https://www.rcem.ac.uk/docs/

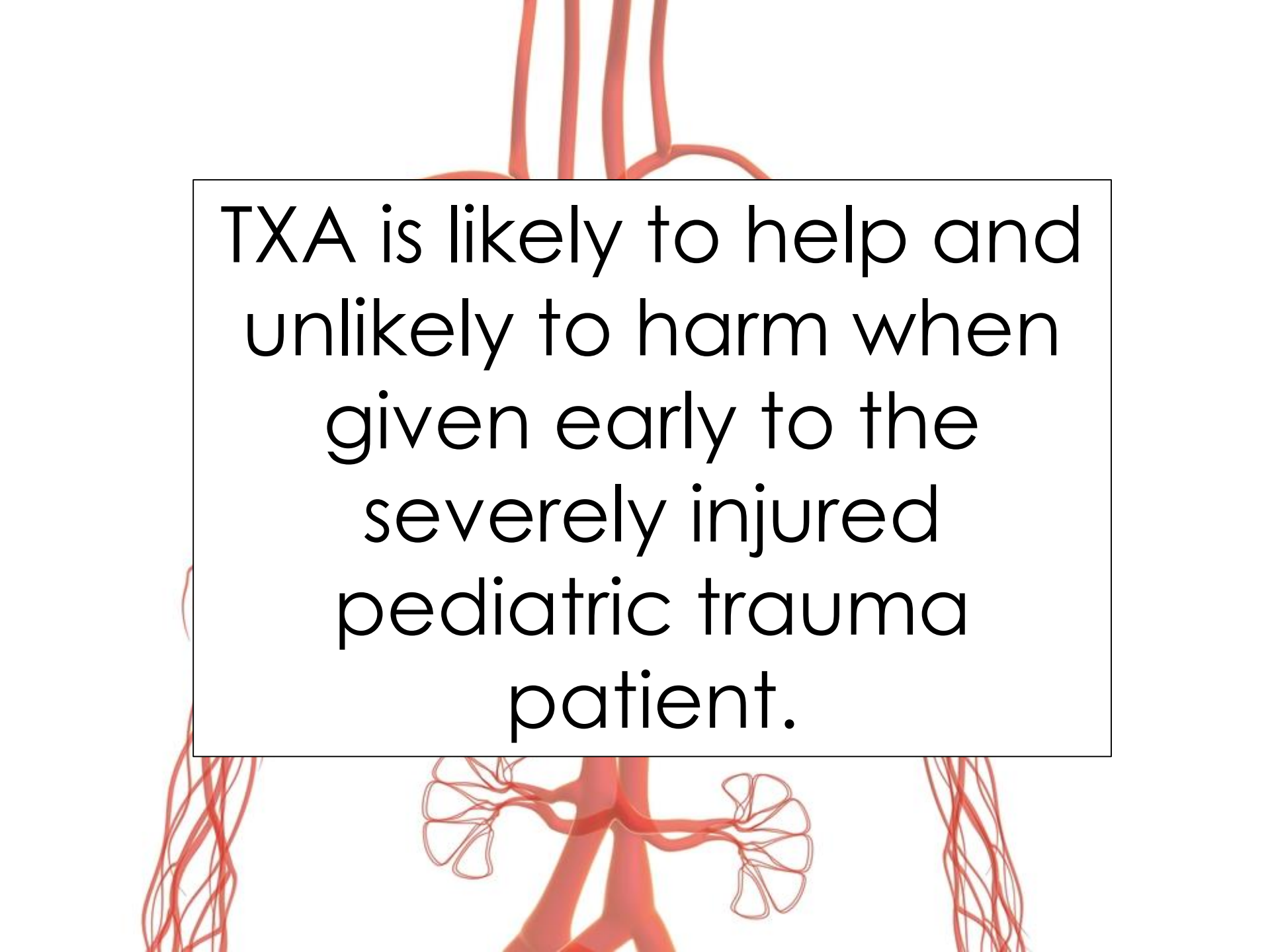
Thicker than Water



FAST hasn't been very helpful so far in pediatric trauma.

But we just might need to learn to do it better in kids.


Permissive hypotension in pediatric trauma is probably a bad idea.
But giving blood early is probably a good idea.



TXA is likely to help and unlikely to harm when given early to the severely injured pediatric trauma patient.